California Redwood ... its properties and uses

SECTION VI
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Basis and authentic information by the United States Government

All statements on the first three pages of this article are excerpts from U. S. Government bulletin, "California Redwood and Its Uses," prepared by Forest Products Division of Department of Commerce.

Redwood's excellent gluing characteristics make it ideal for core stock and many other gluing operations.—Photo courtesy S. Karpen and Bros.

PHYSICAL, MECHANICAL AND CHEMICAL PROPERTIES

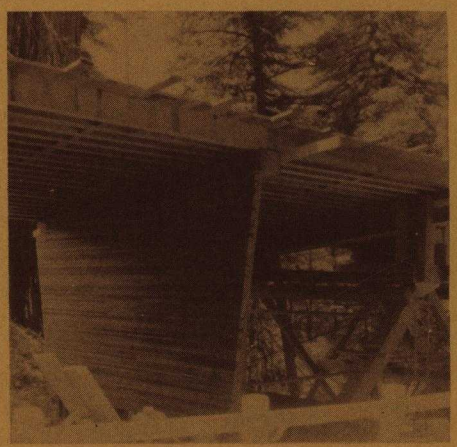
DURABILITY: Relatively few woods produced throughout the world possess as high a degree of resistance to decay and insect attack as American California redwood. The United States Forest Products Laboratory* classes redwood heartwood among a limited number of American woods, which according to actual service records, are durable when used under conditions that favor decay. This accounts for redwood being so successfully employed for exterior parts of buildings for siding and shingles, for stadium seats, for silos and tanks, for bridges and trestles, for pipe lines and flumes, in fact for most any out-of-door work where exposure requires a serviceable, lasting wood.

As early as 1776 the Franciscan missionaries realized the natural durability of redwood and used it in the construction of Mission Houses in San Jose and San Francisco. After more than 150 years of service the posts and beams in these structures are still sound.

Termites, commonly called white ants, are the most destructive insect enemies of wood. The heartwood of California redwood contains certain elements which are believed to impart to the wood the characteristics of a natural preservative, making it one of the most termite-resistant woods produced in the United States. This is verified by actual tests conducted by the Bureau of Entomology† of the United States Department of Agriculture.

STRENGTH AND WEIGHT

Redwood is one of the lightest softwoods commonly used for structural purposes, weighing only 28 pounds per cubic foot in an air-dry condition of 12 percent moisture content, but at the same time it possesses comparatively high strength properties. In fact, the Forest Products Laboratory‡ states, with regard to tests made on redwood, that it 'was higher in such properties as bending strength, crushing strength, and hardness than would be expected from its specific gravity.' Combining the desirable qualities of strength and natural durability accounts for redwood being extensively employed for many structural purposes, such as highway bridges, trestles, and mill roofs.



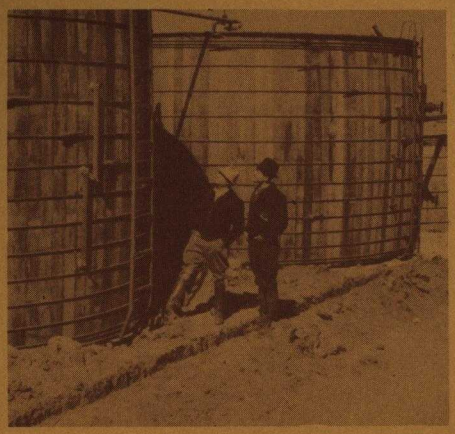
Firewalls of Redwood crib construction protect highway bridge. Also used in and under warehouses, piers, and in industrial plants. Redwood is non-resinous and contains no turpentine; ignites slowly and burns slowly. A charred portion tends to adhere and protect unburned wood beneath.

The American Railway Engineering Association Bulletin, Volume 36, No. 374, published in February, 1935, and the American

*Wood Handbook, U. S. Department of Agriculture, Forest Products Laboratory. September 1935.

†Tests of Methods of Protecting Woods Against Termites or White Ants, by Dr. T. E. Snyder, Bureau of Entomology, U. S. Department of Agriculture. Department Bulletin No. 1231, June 26, 1924 (p.14). Injury to Buildings by Termites, by Dr. T. E. Snyder, Division of Forest Insects, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. Leaflet No. 101, June 1936 (p.4).

‡The Strength and Related Properties of Redwood. Forest Products Laboratory of the U. S. Department of Agriculture, Technical Bulletin No. 305. 1932.



Redwood treating tank, settling tank, and stock tanks. Used in mid-continent oil fields . . . the most economical lease tanks known.—Courtesy Black, Sivalls-Bryson, Inc., Oklahoma City.

"Association of State Highway Officials specifications include the following recommendations for redwood 'Standard Stress-Grades and Working Stresses':

	POUNDS PER SQUARE INCH			
Grade Name	Extreme fiber in bending	Shear parallel to grain	Compression perpendicular to grain	Modulus of elasticity
1,600 # f close grained*	1,600	80	267	1,200,000
1,400 # f close grained*	1,400	80	267	1,200,000
1,200 # f close grained*	1,200	70	267	1,200,000

*Close-grained redwood shall average on either one end or the other of each piece not less than 10 nor more than 35 annual rings per inch.

The working stresses given above are for long-continued load, and are considered safe under circumstances where failure would cause personal injury or large property damage.

For loads that will remain on the structure for a short time only, somewhat higher working stresses may be used.

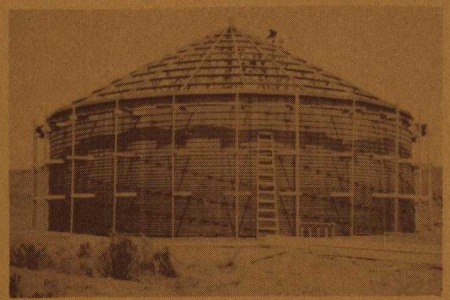
The stresses may be used without regard to impact, unless the impact stress exceeds the allowable live-load stress.

SHRINKAGE AND SWELLING

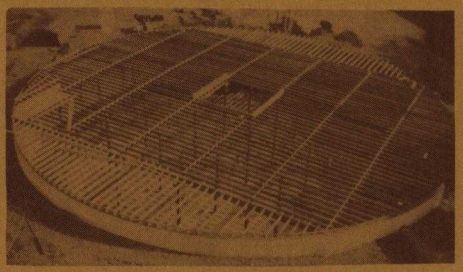
Another outstanding quality of redwood, which makes it so desirable for both outdoor and interior purposes, is its low shrinkage or swelling under variable conditions of moisture. Official tests† show that redwood shrinks only 2.0 percent in a radial direction (across the vertical grain) and 3.3 percent in a tangential direction (across the flat grain) from a green, unseasoned condition to a 6- to 7-percent moisture content.

The low shrinkage of redwood makes it particularly suitable for tanks and vats of various types which are oftentimes subject to wet and dry conditions.

Similarly, when used for out-of-door purposes, where it is subject to rain one day and sunshine the next, redwood has been found to stay in place well, with little, if any, tendency to warp or split. It is also a fine wood for certain interior uses, since, because of its low shrinkage, it is not noticeably affected by the dry heat found in many homes and buildings in the winter. The Forest Products Laboratory states‡ that 'the relatively low shrinkage of the heartwood across the grain commends redwood for uses where this property is important.'



Erecting a redwood water storage tank—67 feet diameter by 20 feet height — capacity 500,000 gallons.—Courtesy Pacific Tank & Pipe Co., Oakland, Calif.



Redwood is favored for sheathing, framing and supports of reservoir roof construction.

NAIL-HOLDING POWER

Many years of experience have demonstrated that redwood has very satisfactory nail-holding power. Official tests† on the lateral resistance of various commercial woods to common wire nails, places redwood in the group of important woods with a relatively high resistance.

GLUING

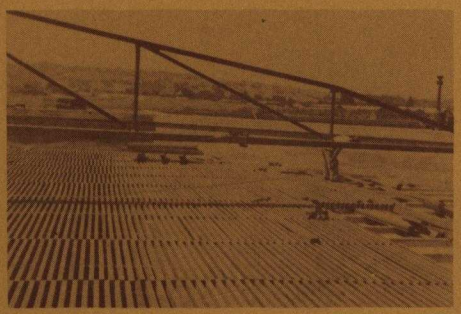
The Forest Products Laboratory states that a species is considered to be glued satisfactorily when the strength of the joint obtained is approximately equal to the strength of the wood. The Laboratory† classes redwood in the group of a relatively few woods that glue easily with different glues under a wide range of gluing conditions.

RESISTANCE TO CHEMICALS

Many of our important industries, such as textile, paint, leather, soap, pulp and paper, and mining, have found that redwood tanks or vats have met their requirements in handling various solutions, even including definite percentages of organic and inorganic acids and alkalies.

The wine, brewing, and distilling industries use redwood extensively for general fermenting and storage tanks.

The foodstuffs industry commonly uses redwood tanks in processing olives and pickles; for the storage of ciders, fruit juices, and extracts; and cheese manufacturing.



Installing Redwood grids in bio-filter sewage disposal unit.

The petroleum industry finds widespread use for redwood tanks for they give particularly satisfactory storage for corrosive oils. Other uses for redwood tanks are found in the glue industry and in the manufacture of inks.

The redwood industry considers tank and vat stock as one of its most outstanding products and is prepared to co-operate with industry in solving any tank or vat problem.

TASTE, ODOR, AND EXTRACTIVES

An outstanding property of redwood, verified by long service records, is the fact that it imparts no noticeable taste or odor to liquids or solids. For many years redwood tanks have been used in the manufacture of the finest liquors and in processing many food products.

The wood of many species contains quantities of complex substances such as resins, gums, and oils of one nature or another. These substances in the heartwood of redwood are more or less reddish, which to quite an extent accounts for the distinctive color of the wood. They are also believed to have an important bearing upon its relatively low shrinkage and high resistance to

†Wood Handbook, U. S. Department of Agriculture, Forest Products Laboratory. September 1935.

‡The Strength and Related Properties of Redwood. Technical Bulletin No. 305, 1932.

decay, as well as certain of its strength properties.

RESISTANCE TO FIRE

The absence of resins, or gums, in redwood makes it a naturally fire-resistant wood. No claim is made that redwood is not combustible, but from actual cases where intense fires have destroyed industrial plants, redwood tanks, and laminated roofing and walls have escaped with only superficial charring.

INSULATION

Wood possesses the best insulating properties of any of the basic structural materials now commonly used. The lighter the wood the better is the insulating value. According to tests made by the University of Minnesota, on the thermal conductivity of the more important commercial woods, redwood ranked among those having the highest insulating values. For railway cars, cold-storage plants, refrigerator boats, greenhouses, and mill roofs, not to mention homes, the importance of using a wood having a high insulation value is apparent.

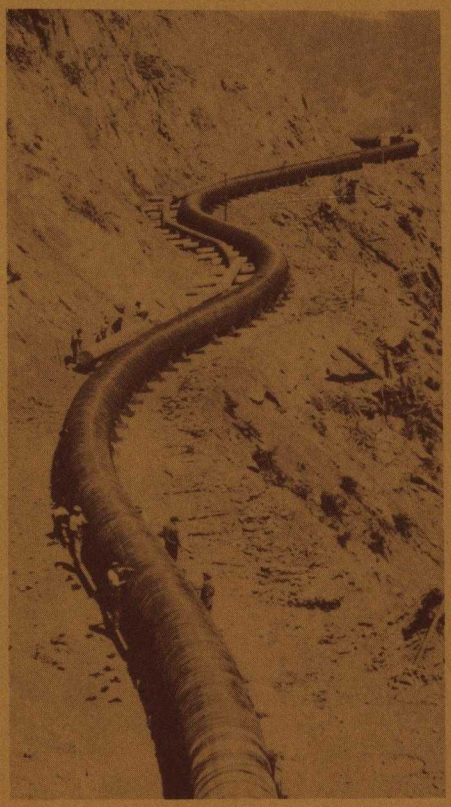
USES OF REDWOOD

In the foregoing paragraphs specific references have been made to the uses of redwood with particular regard to its several outstanding properties. Throughout the world American California redwood has established an enviable reputation as a superior wood for many and various purposes. Its great durability has probably accounted for much of its popularity, especially where chemically treated lumber is undesirable or unobtainable. While redwood finds its greatest application for miscellaneous out-of-door construction purposes it has also been found to be a valuable industrial wood.

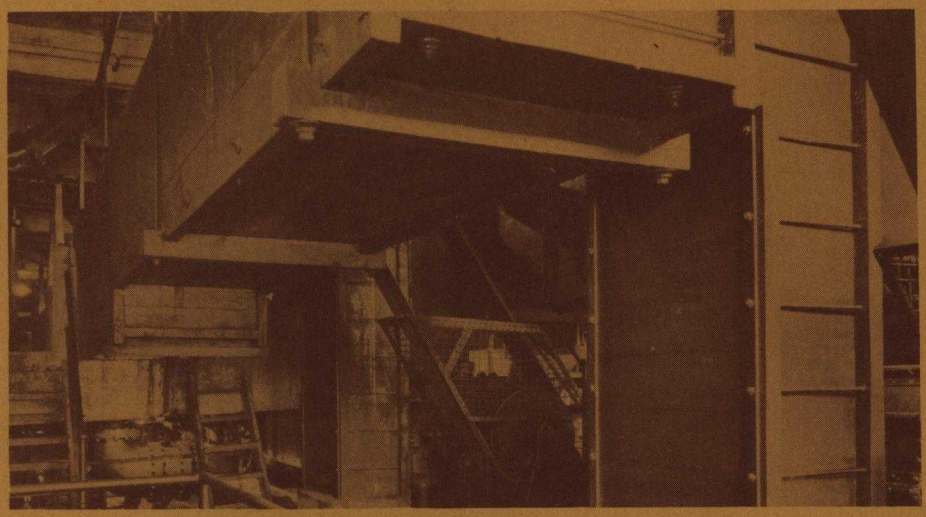
As a specialty wood California redwood meets many difficult requirements. The sawmills produce special heart grades for tanks, vats, silos, pipes, and siding. Another important item is shingles, both sawn and hand rived (split). For construction purposes special heart yard and structural grades are produced to meet the demand for combined strength and natural durability.

Too much cannot be said about the adaptability of redwood for tanks and vats or similar applications. In industrial plants in most any country of the world one is likely to find redwood water-storage tanks or chemical vats. On the farm it is commonly used for silos and tanks. In irrigation projects it is an ideal wood for flumes, reservoirs, dams, pipe lines, diversion boxes, etc. Many large American cities depend upon redwood pipe lines for their drinking water supply. Industrial cooling towers of redwood have given years of satisfactory service.

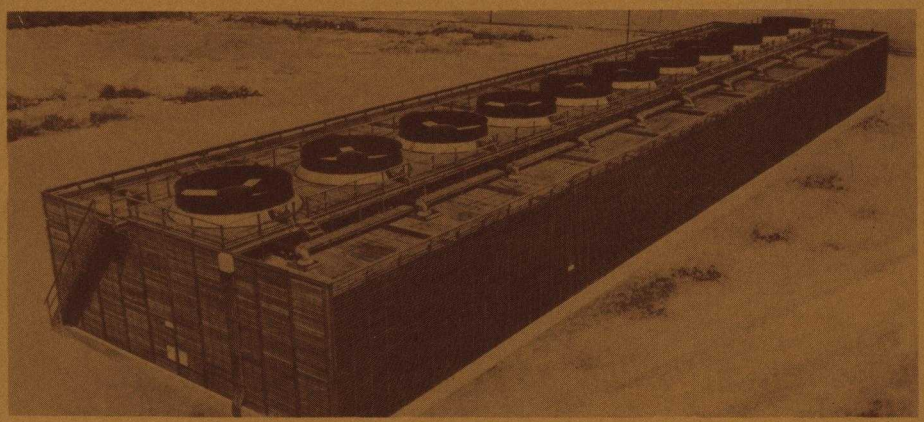
For outdoor construction redwood has been widely used for bridges, trestles, reservoir roofs, culverts, guard rails, posts, signs, etc. Dozens of large stadiums in the United States have redwood seats.



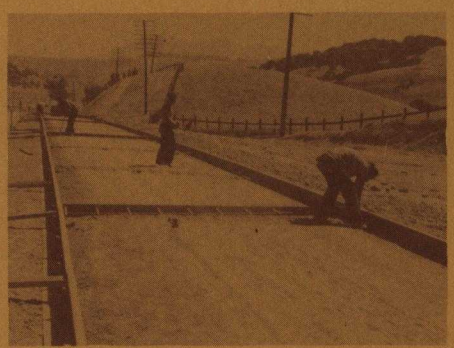
Redwood continuous stave pipe (furnished in diameters from 10 inches to 16 feet) is erected in place and accommodates itself to difficult terrain.



Redwood is ideal for paper mill screen construction.



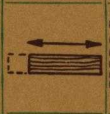
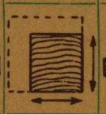
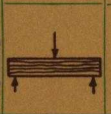
Redwood cooling tower construction.—Courtesy The Marley Company, Kansas City, Kansas.



Installing Redwood expansion joints in concrete highway. Also used in concrete airport runways.

Average Comparative Properties of Clear and Virgin-growth Redwood Compared with a Number of Other Species

(From Technical Bulletin No. 305, July 1932, The Strength and Related Properties of Redwood, by R. F. Luxford, Associate Engineer, and L. J. Markwardt, Senior Engineer, Forest Products Laboratory Branch of Research, Forest Service, U. S. Dept. of Agriculture)

Commercial and botanical name of species	Trees tested	Specific gravity, oven-dry, based on volume when green	Weight per cubic foot		Shrinkage from green to oven-dry condition based on dimensions when green			Composite strength values				
			Green	At 12 per cent moisture content	Radial	Tangential	Volumetric (composite value)	Bending strength	Compressive strength (endwise)	Stiffness	Hardness	Shock resistance
												
1	2	3	4	5	6	7	8	9	10	11	12	13
	Number		*Pounds*	*Pounds*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Redwood [1] (Sequoia sempervirens)	16	0.39	52	28	100	100	100	100	100	100	100	100
Cedar, Port Orford (Chamaecyparis lawsoniana)	14	.40	36	29	192	172	158	99	87	123	89	122
Cedar, eastern red (Juniperus virginiana)	5	.44	37	33	129	118	116	81	84	58	150	175
Cedar, western red (Thuja plicata)	15	.31	27	23	100	125	113	72	72	79	70	80
Cedar, northern white (Thuja occidentalis)	5	.29	28	22	88	118	103	60	50	57	56	72
Cypress, southern (Taxodium distichum)	26	.42	50	32	158	155	155	95	89	99	96	117
Douglas fir (Pseudotsuga taxifolia) (Coast type)	34	.45	38	34	208	195	181	108	104	132	109	125
Douglas fir (Pseudotsuga taxifolia) (Rocky Mountain type)	10	.40	35	30	150	155	154	90	81	104	96	103
Fir, lowland white (Abies grandis)	10	.37	44	28	133	180	157	87	80	114	80	111
Fir, noble (Abies nobilis)	9	.35	30	26	188	208	188	89	74	109	72	105
Fir, silver (Abies amabilis)	6	.35	36	27	188	250	212	84	74	107	69	108
Fir, white (Abies concolor)	20	.35	47	26	133	175	142	87	71	93	78	92
Firs, white (Average of four species)	45	.35	41	26	158	198	164	87	74	103	76	102
Hemlock, western (Tsuga heterophylla)	18	.38	41	29	179	198	179	89	82	105	93	112
Pine, loblolly (Pinus taeda)	10	.50	54	38	229	188	190	112	101	121	115	143
Pine, longleaf (Pinus palustris)	34	.55	50	41	221	188	185	128	119	138	141	158
Pine, northern white (Pinus strobus)	18	.34	36	25	96	150	124	76	65	87	65	85
Pine, shortleaf (Pinus echinata)	12	.49	51	38	212	205	191	117	101	124	126	171
Pine, sugar](Pinus lambertiana)	9	.35	51	25	121	140	118	77	66	82	70	85
Pine, western white (Pinus monticola)	14	.36	35	27	171	185	176	83	73	100	65	100
Pine, ponderosa (Pinus ponderosa)	31	.38	45	28	162	158	145	78	67	82	76	89
Spruce, Sitka (Picea sitchensis)	25	.37	33	28	179	188	173	87	73	105	81	117

[1] Columns 6 to 13 are based on figures for comparative properties for redwood of 2.4, 4, 67, 83, 103, 137, 54, and 65, respectively, which, owing to the greater number of tests, supersede the comparative figures given in U. S. Department of Agriculture Technical Bulletin 158 (*8*).

Working Stresses for Structural Redwood

(For permanent structures in "wet and dry" locations)

NOTE: Structural grades are usually specified in accordance with the standard grades of the California Redwood Association, rather than the stress grades described in the quotation from the Department of Commerce booklet. The grade names and safe working stresses recommended by the California Redwood Association for use when competent engineering design, accurate fabrication, and adequate construction supervision is applied, are as follows:

ITEM	POUNDS PER SQUARE INCH	
	Dense Structural	Heart Structural
Modulus of elasticity	1,200,000	1,200,000
Extreme fiber in bending	1,700	1,300
Compression parallel to grain	1,450	1,100
Compression perpendicular to grain	320	320
Shear parallel to grain	110	95

Unusual and interesting design for a large highway bridge, constructed of Redwood.

GENERAL CONSTRUCTION USES

Siding
- Bevel and Bungalow
- Anzac
- Rustics and Drop Siding

Exterior Finish
Interior Finish, Paneling
Millwork
Foundation Sills
Boards and Dimension
Structural Timbers
Mill and Factory Roofs

INDUSTRIAL USES

Airports:
- Catch Basins
- Culverts
- Expansion Joints for Concrete Runways
- Hangars

Batteries: (separators)

Boats:
- Benches
- Bottoms
- Decking
- Finish
- Panels
- Refrigerator Hold Lining

Boxes:
- Ammunition
- Cigar
- Candy
- Flower
- Novelty
- Signal Instrument

Bulkheads

Caskets:
- Cases and Shells
- Outer Burial Boxes

Cooling Towers

Culverts

Doors:
- Fire
- Garage
- Interior and Exterior
- Refrigerator

Fences:
- Boundary
- Garden
- Industrial

Finish:
- Interior
- Exterior

Fire Resistance:
- Cores for Metal Clad Fire Doors

Fire Resistance (Cont.):
- Laminated Fire Walls

Fixtures:
- Office
- Store

Flooring:
- Block Floors
- Machine Floors

Flour Mills:
- Chutes
- Side Boards for Conveyors
- Spouts

Flumes

Foundries:
- Flasks
- Patterns
- Templates

Frames:
- Door
- Hot Bed
- Window

Furniture:
- Built-in Types
- Core Stock
- Garden
- Kitchen

Greenhouses:
- Benches

Greenhouses (Cont.):
- Flats
- Flower Boxes
- Greenhouse Buildings
- Hot Bed Sash

Gutters:
- Built-up Downspouts
- Built-up Gutters
- Molded Pattern Gutters

Highways:
- Bridge Construction
- Culverts
- Expansion Joints for Concrete Pavement
- Guard Rails
- Highway Signs and Posts

Kitchens:
- Cabinets
- Furniture
- Ironing Boards

Luggage

Millwork (General)

Moldings

Mushrooms:
- Houses
- Trays

Pipe:
- Bored
- Continuous Stave

Pipe (Cont.):
- Machine Banded

Plywood

Railroads:
- Block Floors
- Crossing Gate Arms
- General Building Purposes, Frames, Siding, etc.
- High Grade Utility Finish
- Longitudinal Refrigerator Car Siding
- Pattern Stock
- Roof Gutters and Downspouts
- Round House Roofs
- Running Boards
- Signal Instrument Boxes
- Signs and Sign Posts
- Stock Guard Slats and Wing Fences
- Switch Ties and Ties for Industrial Tracks
- Tanks
- Trunking and Capping
- Tunnel Lining

Refrigerators:
- Inside Lining, Ceiling, Exterior Boarding and Framing for Refrigerator Boxes

Refrigerators (Cont.):
- Staving for Refrigerator Holds

Reservoirs:
- Roof Sheathing and Framework
- Roof Supports

Retaining Walls

Sewage Disposal Plants:
- Flights
- Grids
- Lining for Concrete Structures
- Septic Tanks
- Purification Tanks

Ships:
- Bulkhead Lining
- Cabinets
- Interior Finish and Trim
- Overhead or Ceiling Application
- Staving

Silos

Stadiums:
- Footboards
- Seats
- Framework

Tanks and Vats

For detailed engineering data on any subject write

California Redwood Association 405 Montgomery, San Francisco

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